A WATER-RESISTANT ANIMAL GLUE

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UNITED STATES DEPARTMENT OF AGRICULTURE
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FOREST PRODUCTS LABORATORY
Madison, Wisconsin
In Cooperation with the University of Wisconsin

A WATER-RESISTANT ANIMAL GLUE

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The Forest Products Laboratory has found that it is practicable to give ordinary animal glue a fairly high degree of water-resistance by incorporating certain chemicals with it just before application. A detailed description of the experiments was published in Industrial & Engineering Chemistry, Vol.19, p.215, February 1927. The formula herein described has given very excellent results on the laboratory scale and is believed suitable for certain types of manufacturing operations. In a typical test with three-ply panels of 1/16-inch birch veneer, average shearing strengths of 475 pounds per square inch when dry and 165 pounds per square inch after soaking in water for 2 days were obtained. This is within the range of values shown by good water-resistant casein glues.

The Formula

Animal glue.....	100	parts by weight
Water[1].....	225	parts by weight
Oxalic acid.....	5.5	parts by weight
Paraformaldehyde...	10	parts by weight

The glue is soaked in the cold water until the granules or flakes have been softened. It is then melted at about 140° F. after which the temperature is allowed to fall to between 105° and 115° F. The oxalic acid, in small crystals, and the paraformaldehyde (a fine, white powder) are then mixed together and added to the glue. The mixture is stirred until all of the oxalic acid has gone into solution, after which it is ready for use. Another good procedure is to soak and melt the glue in 200 parts of water, saving the other 25 parts to moisten the paraformaldehyde and oxalic acid before adding them to the glue solution. Any tendency for the paraformaldehyde to form dry lumps when incorporated in the glue is thereby eliminated.

Precautions in Using the Glue

At a given temperature the addition of the oxalic acid and paraformaldehyde lowers the viscosity of the glue slightly. But the new glue is used at lower temperatures than are customarily employed for animal glue so that the difference in viscosity brought about by the added ingredients is compensated for by the effect of the lower temperatures at

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[1] The proportion of water will depend upon the grade of glue employed and the viscosity of solution desired. In general, the proportion will be the same as would be employed when using the glue in question without addition of chemicals.

which it is used. It will be understood, of course, that the water content may be altered at will to give a glue of any desired viscosity or to suit the requirements of different grades of animal glue.

Care must be taken to keep the glue within the proper range of temperature. At a temperature between 105° and 115° F. and when using the proper type of paraformaldehyde, the glue will remain in a fluid condition for 6 to 8 hours from the time of incorporating the paraformaldehyde and oxalic acid, after which it will set to a tough, firm jelly which cannot be melted again. It is important to avoid heating the glue mixture above 115° if a long working life is required. At 120° the working life is 5 to 6 hours and at 140° it is only 2-1/2 to 3 hours. The working life does not seem to differ materially with animal glues of widely varying grade.

The low temperatures advised can be employed without danger of decomposition of the glue through bacterial action because paraformaldehyde is an excellent antiseptic. Because of this lower temperature and the lower gel-point caused by the added chemicals, a slightly longer assembly period may be allowed in the gluing operations than would ordinarily be employed with the grade of animal glue used.

The paraformaldehyde does not dissolve in the glue at once, but most of it remains suspended as a finely divided solid during the working life of the glue. A certain amount of agitation is therefore necessary to keep it evenly distributed throughout the mixture, preventing its settling to the bottom of the container. The paraformaldehyde used should be a fine enough powder to pass completely through a 50-mesh sieve, in which case the amount of agitation provided by the mechanical glue spreader is sufficient to keep the paraformaldehyde stirred up. The glue should be stirred thoroughly in the mixer just before taking it to the spreader or to bench glue pots.

It is also important to use up a batch of glue and clean the spreading machinery and glue pot before the glue sets to a jelly because the tough, insoluble jelly is not easy to remove.

Type of Paraformaldehyde to Use

Commercial paraformaldehyde varies materially in certain of its properties, notably in its chemical reactivity. When used in this formula, some types of paraformaldehyde cause the glue to set to an unworkable jelly in a much shorter period of time than the working life as stated above. For example, glues were made up in accordance with the formula using paraformaldehyde from five different factories and the range in working life at 115° was found to be as follows:

Source of paraformaldehyde	Working life of glue
Factory number	Hours
1	6.5
2	5
3	3
4	2.75
5	2.5

By heating a fast-reacting paraformaldehyde in a closed container at 212° for several days it can be made slow-reacting. The chemical reactivity, however, is subject to control during the manufacture of the paraformaldehyde and two companies have stated that they are able to furnish on order a type suitable for use in this formula. Their names will be supplied on request. Presumably other paraformaldehyde manufacturers can also if specially requested.

Influence of Grade of Glue

When glues of different grade are employed in this formula it is necessary to vary the amount of water used in order to maintain the same viscosity of the glue solution, just as would be the case in employing the glues without addition of chemicals. Aside from this, different animal glues give approximately the same results. Such small differences in working life, joint strength, and water-resistance as are observed with individual animal glues seem to be more or less independent of the glue grade measured in terms of viscosity and jelly strength as the following results show:

Grade of glue[1]		Working life	Plywood tests		Joint test	
Viscosity	Jelly strength		Dry	Wet	Lbs. per sq. in.	Wood failure
Millipoises	Grams	Hours	Lbs. per sq. in.			Percent
118	372	7	449	139	3,560	31
95	299	7-1/4	463	163	3,600	36
76	240	6-1/4	452	155	3,385	38
65	190	7	---	---	---	--
55	131	7	449	113	3,720	39

[1] Glue grade measurements were made by the methods of the National Association of Glue Manufacturers. Indus. Eng. Chem. 16, 310, 1924.

Water-Resistance Develops Slowly

Test panels for determining the degree of water-resistance of this formula should be seasoned after gluing for at least 10 days before subjecting them to the soaking test because the full degree of

water-resistance is developed slowly. A number of panels were made up with a single batch of glue and seasoned for varying lengths of time before testing, with the following results:

Days seasoning	Plywood test, wet Lbs. per sq. in.
2	20
3	65
5	95
7	115
9	140
10	150
12	145
17	155

It should also be noted that the water-resistance of glues made by this formula is comparable with that of casein glues when the soaking test is carried out in water at ordinary room temperatures or less, but in water at higher temperatures the values obtained in the test on the paraformaldehyde animal glue decrease with increasing temperatures. Thus, a series of tests gave the following data:

	Lbs. per sq. in.
Specimens tested dry...	409
Specimens tested wet after 2 days' soaking in water at:	
59° F. ...	188
77° F. ...	174
95° F. ...	138
113° F. ...	94
140° F. ...	0

Other Chemicals that may be Used

Both oxalic acid and paraformaldehyde are poisonous materials. Proper precautions should be taken to see that they are not ingested by men using them. The oxalic acid can be replaced by an equal weight of the nonpoisonous mucic acid. Any acid will serve to extend the working life to a satisfactory period, but many of them affect either the dry strength or the water resistance adversely. There are a number of other substances that can be used in place of paraformaldehyde, but they all give off formaldehyde in the glue and are therefore just as objectionable from the point of view of poisonousness as paraformaldehyde. Further details regarding them will be found in the reference previously cited.

There is no detectable odor of formaldehyde in panels glued with this formula.

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This glue may prove of value where high water-resistance is desirable and where other glues are not suitable for one reason or another. It is not alkaline and will not stain thin veneers. There is no reason to suppose that it will dull wood-working tools to any greater extent than ordinary animal glue.

Persons contemplating trying out this formula should communicate with the Forest Products Laboratory, Madison, Wis., if they wish its suggestions in adapting the process to their special requirements.